1. (30 pts) Triangle ABC has vertices at $A(2, 1, 0)$, $B(6, -2, 0)$, and $C(7, 3, 0)$.

   (a) Find a vector of length $\frac{1}{5}$ in the same direction as $\overrightarrow{AB}$.

   (b) Find an equation in symmetric form for the line passing through A and B.

   (c) Find all unit vectors orthogonal to both $\overrightarrow{AB}$ and $\overrightarrow{AC}$.

   (d) Find the area of $\triangle ABC$.

   (e) An altitude is drawn from vertex C to side $\overline{AB}$. Find a unit vector parallel to this altitude.

2. (30 pts) Axis Ant begins on the ground and walks along a straight path

$$\mathbf{r}(t) = t\,\mathbf{i} + (-1 + 2t)\,\mathbf{j} + 2t\,\mathbf{k}, \ \ t \geq 0.$$

   When it reaches point $P(1, 1, 2)$, it sees Butter Fly hovering at point Q.

   (a) Given vector $\overrightarrow{PQ} = \langle 3, -2, 6 \rangle$, how high above the ground is Butter Fly?

   (b) What is the angle between $\overrightarrow{PQ}$ and the path?

   (c) Find an equation for the plane containing both the path and point Q. Fully simplify your answer.

   (d) Butter Fly remains at Q while Axis Ant continues walking along the path until it reaches R, the point on the path closest to Q. What is the distance Axis Ant travels from P to R?

3. (20 pts) Consider the surface $4y^2 - z^2 - 4x - 24y - 4z + 32 = 0$.

   (a) Write the equation in standard form.

   (b) Identify the surface by classifying the type of curves in the $x = 0$, $y = 0$, and $z = 0$ traces.

   (c) Suppose the surface is intersected with $z = 2y - 2$. Find a vector function representing the curve of intersection.

4. (20 pts) Beta Bug leaves home at time $t = 0$ and travels along the path

$$\mathbf{r}(t) = t\sin(t)\,\mathbf{i} + \cos(t)\,\mathbf{j} + (12\pi - 3t)\,\mathbf{k}.$$

   (a) At $t = \pi$, how far is Beta Bug from home?

   (b) At that moment, the bug decides to leave the path and travel in a straight line in the direction of the tangent. Find a vector equation for the line. (The parameter in the equation may begin at 0.)

   (c) Find the coordinates of the point where Beta Bug will land on the ground ($z = 0$).